

World fleet vs. Spanish Bunkering. Its impact on ECAS areas

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Abstract— On December 17 came into force on community standard marine fuels. Bunker prices are expected to increase, recent statistics support this argument and the difference between the high sulphur (HS) and the low sulphur (LS) marine bunkers will be sustained. Considering also the price difference between the basis-market of Rotterdam with the rest European ports, the expected bunker prices will be higher in the Mediterranean.

This paper begins with a review of the current situation in ECAS areas, highlighting the rules to be implemented shortly. The aim of the paper is known the current situation bunkering determine the estimated short term in Spain from world fleet.

Keywords: Spanish bunkering, SECA, ECA, maritime transport

I. INTRODUCTION

The impact of a possible extension at European level of the Sulphur Emission Control Areas (SECA) as they are introduced in the Annex VI of the International Convention for the Prevention of Pollution From Ships, 1973 as modified by the Protocol of 1978 (MARPOL) adopted by the International Maritime Organisation (IMO). Air pollution attracts high political priority as it affects negatively public health and the quality of life. It is a complicated topic both scientifically and politically; conflicting interests of stakeholders are clashing, the scientific basis of their arguments or the rational differs, and potential actions might abate a pollutant yet contribute to the concentration of another. The issue on air pollution is primarily focused on the Green-House-Gases (GHG), primarily on Carbon Dioxide (CO₂) and non-GHG, such as the sulphur oxides (SO_x), nitrogen oxides (NO_x) and particulate matter. MARPOL Annex VI addresses primarily the issue of SO_x, NO_x and CO₂, among others.

As a result of the problems of increasing acidification by acid rain in northern Europe caused by air pollution and due to the contribution of emissions from ships, IMO has appointed the following two SECAs within the EU: Baltic Sea (effective May 2006), the North Sea and English Channel (effective

November 2007). The standard EU limits described in Directive 1999/32/CE are less stringent than the limits in Annex VI of MARPOL. The note explores the risks associated with the expansion of the current SECA in the EU; this is valued including an introduction of new areas of sulphur oxide (SO_x) Emission Control, and perhaps even a SECA expansion along the entire coastline of the EU.

Air pollution is a sensitive issue as it affects the quality of life of many people and has a direct impact on their health. Most of the Europeans are living close to the coastline and all main ports are bordering or are part of large urban complexes. The environmental impact of maritime operations, such as navigation, loading and unloading of cargoes, ship-repair and shipbuilding activity, etc. involves the emission of SO_x, nitrogen oxides (NO_x) and particulate mater (of 2.5 or 10 nm). NO_x emissions are related to nutrient overload in water bodies that leads to eutrophication, and the excess of nutrient nitrogen can be detrimental to marine ecosystems and generally to ecosystems with a fragile balance. SO_x are related to public health issues, such as asthma, bronchitis and heart failure. NO_x and SO_x in combination might cause acid depositions that can be detrimental to the natural environment (lakes, rivers, soils, fauna and flora). SO_x and NO_x emissions at sea can exert an influence on vegetation and land-based objects many thousands of kilometres away [1].

The topic cannot be analysed thoroughly in few pages; many academic studies have identified controversial issues, conflicting interests and goals, as well as methodological issues that determine the outcome of an analysis. Nevertheless it should be highlighted that most studies focus on air pollution generally and not specifically on the sulphur issues. This note aims to summarize key issues and points discussed in leading studies as well as in significant policy documents and address the requirements of the tasks.

References and links to the sources are provided, however a degree of 'subjectivity' is inserted, as the requirements demand

a degree of forecasting, which inevitably reflects biases and personal beliefs.

The issue of air pollution and particularly the abatement of SO_x emissions from ships, became a strategic goal of the EU in 2002. The Directive 2005/33/EC of the European Parliament and of the Council regulates the sulphur content of marine fuel, came into force in 2005. This regulatory action is streamlined with Directive 1999/32/EC, which relates to a reduction in the sulphur content of certain liquid fuels; this Directive has set the first sulphur limits for marine distillate oil used in EU territorial waters. Moreover, this directive extended the scope of the previous Directive 93/12/EC on the reduction of SO_x emissions to cover certain liquid fuels derived from petroleum and used by seagoing ships. Recently, Directive 2005/33/EC extended the scope of Directive 1999/32/EC to all petroleum derived liquid fuels used by ships operating within Member States' waters. The above European regulatory actions aim to complete international rules and regulations agreed at the IMO and applicable to the world fleet practically. Furthermore, the issue of air pollution has ignited research interest as research and innovative rational approach should be taken into account in order to support actions, opinions and statements in international forums and debates.

Limiting the sulphur content of fuels has been a major concern among European shipping-responsible for 40% of the world fleet, the cost will involve the adequacy of the existing fleet to the new regulations, and therefore, its impact on freight.

II. LITERATURE REVIEW

The main technical reports addressing the issue of Green-House Gases (GHG) and of sulphur are the ones of European Marine Safety Agency (EMSA) of 2010 and of the Joint Research Centre –JRC- [1]. These reports offer the basis for publication of related work in the specialized academic journals. In the academic literature the interest lies on policy, modelling of economic policies as well as on operational issues, such as scheduling and performance. Generally the literature on GHG and air pollution is vast, yet there is no paper focused on the sulphur issues and its impact on shipping.

Substantial influence on the research and policy evolution is attributed to the studies of IMO on GHG (Buhaug et al., 2009), and of the EC (CE Delft and Germanischer Lloyd and MARINTEK and Det Norske Veritas, 2006; Faber et al., 2009), as well as independent position papers, such as that of the DNV [2], [3], [4]. The researchers contributed in the studies have also published their work in relevant academic journals, however the reports provide more comprehensive and integrated approach, and they are also freely available in the Internet. Generally, the work done on air pollution from ships aims to address policy issues, thus by nature more macro- than microeconomic ones; the impact of a regulation at a micro-level is not really discussed.

The interim report of the Seafarers International Research Centre (SIRC) offers an interesting insight on the effectiveness of international regulations on ships' sulphur emissions, based on observation of ship inspections in the UK and Sweden and on interviews with regulators, inspectors and industry stakeholders [5], [6]. As the UK and Sweden are coastal

countries in the Northern European SECA, this reports sheds some light on compliance issues and lessons learned. Towards this direction, the report of [7] on the Baltic NECA and its economic impacts, although is not focused on sulphur emissions, is also helpful to understand both the options for policy makers as well as the risks faced by operators.

In the academic field, the contribution of [8] is notable; the first report on GHG emissions was published in 2008 [8]; the calculation of GHG emissions and the production of statistics on the basis of the world fleet data was the main result of this effort [9]. Outcomes of this report were presented also in the relevant academic press [10]. The focus of this research is primarily statistical. In his next contribution, he is examining the implication of the regulation, by discussing the opportunity cost and applying a logit-deduced modal split [11]. Finally, [12] discuss the issue of speed in container operations, elucidating the impact of air pollution regulation on logistics operations.

Another interesting set of contribution comes from the team of Miola et al. In the JRC study, [1] thoroughly discuss the issue of regulating air emissions from ships. Policy issues, and especially the design of climate change policy are given in [13]. Moreover, in [13], they present an analysis of modelling approaches and available data sources taking into account the findings of their 2010 report. Finally, interesting contributions in the field are those of [14], [15], [16] and [17], primarily focused on policy and environmental impact, as well as of [18], [19], [20].

Almost all source above except the EMSA report of 2010, address issues related to GHG and air pollution in general. The issue of sulphur is marginally considered, as part of the MARPOL Annex VI regulatory pattern. Moreover, there is lack of academic work on the estimation of the financial impact of regulation in the shipping industry; interestingly enough, there is no publication related to other major regulatory changes, such as of OPA90 or ERICA packages. [21], [22] presented a primer on this issue in a peer-reviewed academic conference, and the full work is still under revision [22].

In reality, operators are confronted with shorter time frames related to their day-to-day business and in most cases they deal with uncertain market developments. Their problems are classed as 'fleet mix and management' problems; these problems aim to maximize profits (or to minimize costs), given budgetary, operational and other constraints. Environmental constraints have not been discussed widely yet. Recent contributions in the field, such as that of [23], discuss the reduction of emissions by optimizing speed in shipping routes. [24] published a work with similar focus yet with a more sophisticated formulation. Although the above-mentioned work is in many ways pioneering and the results stimulate academic work, it does not calculate the impact of the new environmental regulation to the operator.

III. INFORMATION ON MARPOL ANNEX VI

The International Maritime Organization (IMO) is a specialized Agency of the United Nations, and its mandate is principally concerned with marine technical and safety issues as well as with marine pollution and prevention of the

environment from activity related to maritime transport. In 1973, IMO adopted the International Convention for the Prevention of Pollution from Ships, now known universally as MARPOL, which has been amended by the Protocols of 1978 and 1997 and kept updated with relevant amendments. The MARPOL Convention addresses pollution from ships by oil; by noxious liquid substances carried in bulk; harmful substances carried by sea in packaged form; sewage, garbage; and the prevention of air pollution from ships. MARPOL has greatly contributed to a significant decrease in pollution from international shipping and applies to 99% of the world's merchant tonnage.

The international maritime transport sector is a significant contributor to the Green House Gas (GHG) emissions, where CO₂ is the dominant polluter that attracts the interest of policy makers. From the data provided by the International Maritime Organisation (IMO), it is clear that transport activity is responsible for almost 27% of the total burden, and the large proportion of it is attributed to road transportation ($\approx 80\%$). International shipping contributes only 2.7%, where ships burning marine diesel oil (MDO) and heavy fuel oil (HFO) are reportedly responsible for around 7% of global NO_x emissions, around 4% of global sulphur dioxide emissions and 2% of global carbon dioxide emissions (International Maritime Organisation, 2009). The annex of this IMO document provides the full report on the updated 2000 study on greenhouse gas emissions from ships, entitled: Second IMO GHG Study 2009 [25]. The issue of emission reduction from ships is high in the political agenda. Stakeholders have expressed controversial arguments and scientists have identified methodological issues and raised concerns. The very first issue is the premonition of 'targeting' the maritime industry. Indeed, from the data provided by IMO and the study [25] it is clear that transport activity is responsible for almost 27% of the total burden, and the large proportion of it is attributed to road transportation. International shipping contributes only 2.7% of the total and aviation 1.9%. Despite the relatively limited contribution, the marine industry has been affected disproportionately, if not targeted.

The above wording of 'disproportional impact' is considered in position papers of maritime interest, highlighting the fact that shipping is the most energy friendly mode of transport, when considered in unit terms. Reports, such as of the International Chamber of Shipping [26], highlight the comparison of the CO₂ emissions between different modes of transport. [1] reports also that "the World Shipping Council representing more than 60% of the global seaborne trade, takes the stand that the adoption of specific maritime emission caps would be inappropriate in the absence of a broader approach to regulation transportation emissions at the national and global level". In various sources, this stance is taken. The point is that shipping is in absolute terms a significant or substantial emitter, however it is the 'greener', in terms of energy consumption and environmental footprint.

Apparently, shipping is a substantial emitter of non-GHG, such as of NO_x and SO_x, and regulatory action has been triggered. The new Annex VI of the international convention of MARPOL came into force on 19 May 2005, and a revised

Annex VI with significant tighten emissions limits was adopted in October 2008 which entered into force on 1 July 2010.

More specifically, the main changes to MARPOL Annex VI are a progressive reduction globally in emissions of SO_x, NO_x and particulate matter and the introduction of emission control areas (ECAs) to reduce emissions of those air pollutants further in designated sea areas. Progressive reductions in NO_x emissions from marine diesel engines installed on ships are also included, with a "Tier II" emission limit for engines installed on ships constructed on or after 1 January 2011 and prior to 1 January 2016; then with a more stringent "Tier III" emission limit for engines installed on ships constructed on or after 1 January 2016, operating in ECAs. Marine diesel engines installed on or after 1 January 1990 but prior to 1 January 2000 are required to comply with "Tier I" emission limits, if an approved method for that engine has been certified by an Administration. The revised NO_x Technical Code 2008 includes a new chapter based on the agreed approach for regulation of existing (pre-2000) engines established in MARPOL Annex VI, provisions for a direct measurement and monitoring method, a certification procedure for existing engines, and test cycles to be applied to Tier II and Tier III engines. The control of diesel engine NO_x emissions is achieved through the survey and certification requirements leading to the issue of an Engine International Air Pollution Prevention (EIAPP) Certificate and the subsequent demonstration of in service compliance in accordance with the requirements of the mandatory, regulations 13.8 and 5.3.2 respectively, NO_x Technical Code 2008 (resolution MEPC.177(58)). Briefly stated, Regulation 13 of Annex VI, determines the following limits (figure 1):

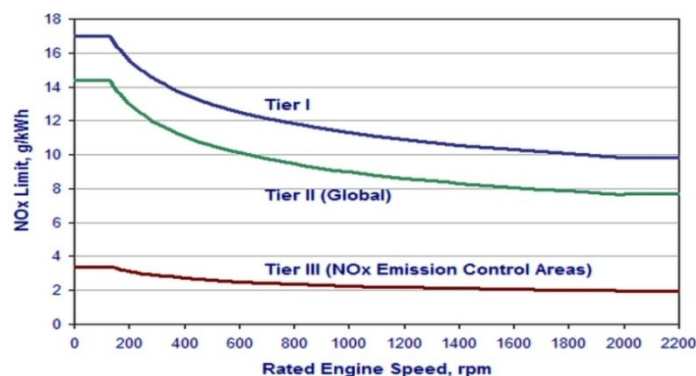


Figure 1. Schematic representation of NO_x reduction.

The Tier III controls apply only to the specified ships while operating in Emission Control Areas (ECA) established to limit NO_x emissions outside such areas the Tier II controls apply. In accordance with regulation 13.5.2, certain small ships would not be required to install Tier III engines. The North American ECA came into force on 1 August 2011 and will take effect from the 1 August 2012. In July 2011, the 62nd session of the Marine Environment Protection Committee adopted the United States Caribbean Sea ECA, which is expected to enter into force on 1 January 2013, taking effect 12 months after (1 January 2014).

Regulation 14 of Annex VI is focused on the sulphur emissions (SO_x). SO_x and particulate matter emission controls

apply to all fuel oil, as defined in regulation 2.9, combustion equipment and devices on-board and therefore include both main and all auxiliary engines together with items such boilers and inert gas generators. These controls divide between those applicable inside Emission Control Areas (ECA) established to limit the emission of SO_x and particulate matter and those applicable outside such areas and are primarily achieved by limiting the maximum sulphur content of the fuel oils as loaded, bunkered, and subsequently used on-board. These fuel oil sulphur limits (expressed in terms of % m/m – that is by weight) are subject to a series of step changes over the years, regulations 14.1 and 14.4 (figure 2).

The ECA currently established are:

- • Baltic Sea area – as defined in Annex I of MARPOL (SO_x only);
- • North Sea area – as defined in Annex V of MARPOL (SO_x only);
- • North American area (expected to enter into effect 1 August 2012)
- • United States Caribbean Sea area (expected to enter into effect 1 January 2014)

At European Union level, certain rules on the sulphur content of marine fuel have been incorporated in the EU Directive 2005/33/EC amending Directive 1999/32/EC relating to a reduction in the sulphur content of certain liquid fuels and amending Directive 93/12/EEC.

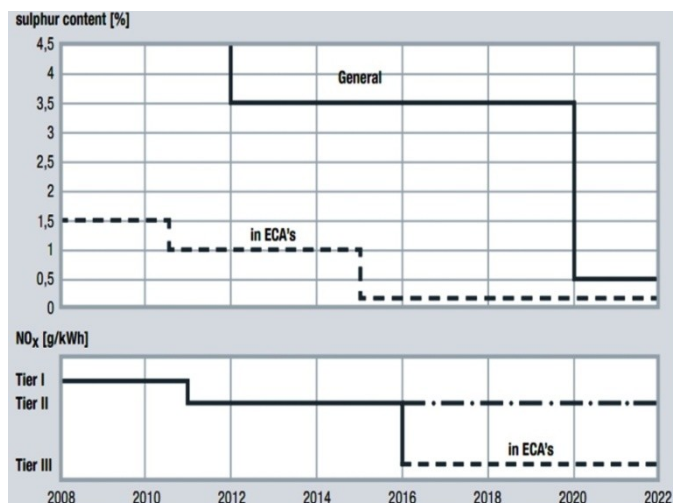


Figure 2. Schematic representation of SO_x reduction

Revisions to the regulations for ozone-depleting substances, volatile organic compounds, shipboard incineration, reception facilities, and fuel oil quality have been made with regulations on fuel oil availability added. The revised measures are expected to have a significant beneficial impact on the atmospheric environment and on human health, particularly for those people living in port cities and coastal communities.

The bunkering in Spain is a mainstay of the economy and therefore must know the short-term estimates will be affected

by this new policy to be implemented in the area ECAS and SECAS.

IV. METHODOLOGY

A. Searching the relationship

Searching the relationship among different economic indicators and tones of bunkering in Spain, different factors are used

- Spain GDP¹ per capita
- GNI² world
- GNI Developed Economies
- GNI Developing economies
- GDP world
- GDP Developed Economies
- GDP Developing economies
- OECD IPI³
- World fleet capacity in GT
- World fleet (number)

All the data use come from UNCTAD and the bunkering Data are obtained from Puertos del Estado (Spain) (table I).

TABLE I. WORLD FLEET VS SPANISH BUNKERING

year	World Fleet (millions gross tones)	Spanish Bunkering (tones of bunkering)
2000	558.054	5533249
2001	574.551	5984704
2002	585.583	6327765
2003	605.218	6565095
2004	633.321	6653263
2005	642.667	7145206
2006	721.855	7401600
2007	704.604	7656294
2008	770.98	7594992
2009	824.692	7623337
2010	882.6	7343290
2011	958	8140807

B. The model

To search the relationship between the factors can be used different regression models, regression analysis is a statistical process for estimating the relationships among variables. It includes many techniques for modeling and analyzing several variables, when the focus is on the relationship between a dependent variable and one or more independent variables. Here we have bunkering and economic indicators. Regression analysis helps one understand how the typical value of the dependent variable (or 'Criterion Variable') changes when any one of the independent variables is varied, while the other

¹ Gross domestic product

² Gross national income

³ Industrial Production Index

independent variables are held fixed: linear, quadratic, exponential and logarithmic

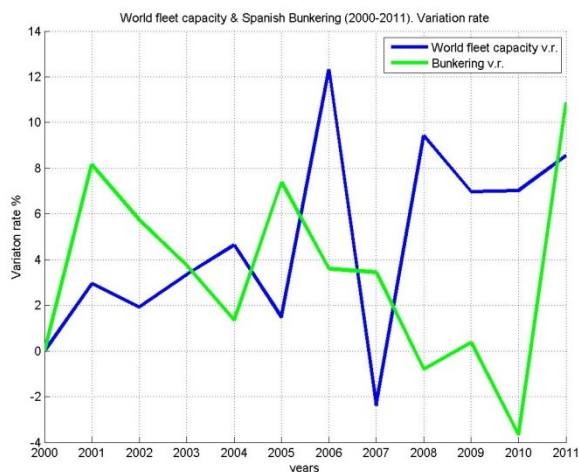


Figure 3. Variation rate %: World fleet vs. Spanish Bunkering

C. Selecting the model

The coefficient of determination, denoted R^2 , indicates how well data points fit a line or curve. It is a statistic used in the context of statistical models whose main purpose is either the prediction of future outcomes or the testing of hypotheses, on the basis of other related information. It provides a measure of how well observed outcomes are replicated by the model, as the proportion of total variation of outcomes explained by the model.

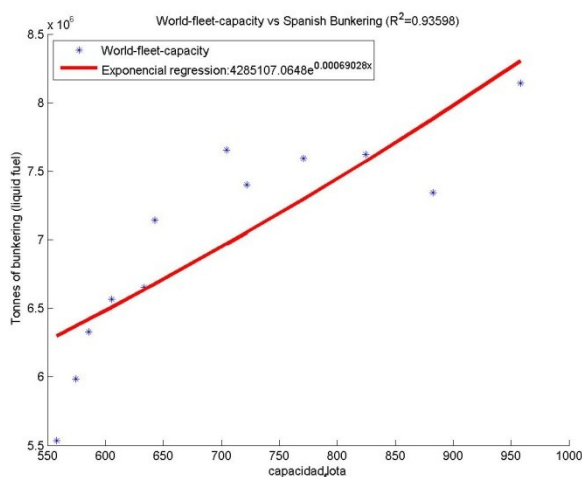


Figure 4. World fleet vs. Spanish bunkering: model

In this way we compare the different models with R^2 and we select the nearest to 1 (Figure 4).

The highest correlation coefficient obtained with the selected models is: using exponential regression (Figure 5).

D. Using the model: obtaining estimations

Using relationship estimated and Puertos del Estado estimations we can calculate the bunkering estimated values in future (example table II).

TABLE II. ESTIMATION WORLD FLEET CAPACITY-VS SPANISH BUNKERING

year	Grow mgt	Estimationn
2012	55.4	8058727.94
2013	79.9	8252378.83
2014	36.6	8463526.32

V. CONCLUSIONS

We obtained a high correlation coefficient by the Spanish bunkering vs World fleet ratio (figure 4). We know the forecasts of world fleet in the coming years, so we can estimate the short-term Spanish bunkering (figure 6), to coincide with the years of implanting of new policies on the SECAS and ECAS areas.

The growth scenario is optimistic world fleet, so the Spanish bunkering short term will continue to grow at a good pace, so ECAS areas affect a greater degree.

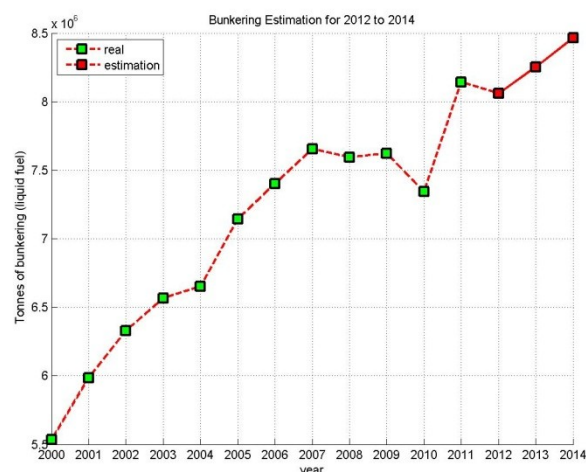


Figure 5. Spanish Bunkering estimation for 2012 to 2014

It is widely recognized the need to reduce SOx emissions from ships for environmental and health reasons because, after all, is a health law and respect for the environment should benefit all citizens of the EU and worldwide. Acid rain is not such a big problem now in Europe and North America ("one of the success stories of recent decades"), but is a major challenge in countries like Mexico, India and China. This is definitely the wave of the future and there will be no turning back. However, there is a need to avoid the negative impacts that the new regulations may bring. It is necessary that the shipbuilding industry, shippers and other affected areas do not meet the entry into force of the laws, but the events are ahead betting on ecological development and invest wisely for a widespread trade ECA.

The main risk of limiting emissions is the immediate increase in costs, which affects the competition, which is favored by not having to implement these measures and offer

their services at lower cost. As for the benefits generated are related to health and the environment, more difficult to measure, and that is achieved in the medium and long term. The same argument of the impact on jobs can be defended in the two positions. The first talk of job losses if more restrictions by sector crisis would be inevitable. While the second speaks of the conversion and the generation of new jobs in a greener shipping industry and modern.

Ships, ports and cities will be involved in policy formulation and decision making. It should work on a joint project to identify needs and to pool knowledge to carry out joint actions.

Obviously, the operation of maritime trade in the Baltic and the North Sea is more expensive than in other regions of the EU and this example raises a very worrying considering extending ECAs: many freight companies, traders and passengers may prefer ground transportation or air. A modal shift from sea to road would be disastrous, because they are already congested, and, at all, would be good for the environment. If this occurs, you get the opposite effect to that intended: increase pollution by shifting mode of transport to another.

To facilitate this transition, the European Union has financing transport systems programs as Trans-European Transport Network (TEN-T) and Marco Polo II program. These lines of community grant support initiatives related to improving environmental conditions through the development of new technologies, provide facilities for alternative fuels enter, such as LNG, and encourage the implementation of mechanisms that enable the use of electricity for conducting maneuvers approaching port.

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